The lens was now removed from the front of the case, and it was replaced by a movable glass plate (1·5 millims. thick); the sounds were the same, but they gradually ceased on gradually uncovering the front opening of the case, so as to give the air room to expand.

The glass plate was replaced by a heavy rigid plate of rock-salt 13 millims. thick, and the sounds were equally loud. The plate was replaced by white note-paper. The sounds were very faint, but perceptible. It was replaced by thin cardboard, and the effect was *nil*.

Hence it is abundantly evident that these sonorous vibrations are due to the motions of the contained air, and not to those of the disk; that they are actually improved by the removal of the disk; that their production is materially assisted by lining the surface of the containing space with an absorbent substance; that they are dependent on the heat rays that pass through; and that they disappear when the rays are cut off from the air cavity by an athermanous diaphragm.

Dr. Tyndall having shown in the paper already referred to, that water vapour responded actively to these intermittent actions, a clean empty one-ounce glass flask was taken and exposed to the intermittent beams. No sound was produced.

It was then filled with water-vapour by pouring a small quantity of water into it, and warming it in a flame; fair sounds were the result.

The flask was filled with the dense smoke from burning camphor, and the sounds were intensified considerably.

Another clear one-ounce glass flask was taken. When clear no sounds were heard. When filled with tobacco-smoke fair sounds, but when filled with heavy camphor smoke very loud sounds were obtained. One side of the flask was blackened on the outside, the other side remaining clear. On exposing the clear side to the light fair sounds were obtained, but on exposing the blackened side, *no sounds were produced*. The flask was blackened *in the interior* on one side only. When the blackened side was near the source fair sounds, and when it was away from the source better sounds were heard. When the flask was cleaned all sounds disappeared. A thin glass plate was now blackened on one side and placed in front of the case. When the black surface was outside *no sounds were obtained*. When the black surface was inside good sounds were the result. When the glass was cleaned the sounds became still better. An ebonite plate was similarly treated. When the blackened surface was outside fair sounds were obtained. When the blackened surface was inside very poor sounds were the result.

This being an anomalous result, several experiments were now made to test the behaviour of opaque and transparent bodies, when used as disks, for while in the previous experiments the effect was greatest when the blackened surface faced the interior, here we find the opposite result produced, viz., the greatest effect was produced when the blackened surface was on the exterior.

Several experiments were then made, from which it appeared that transparent bodies behave in an opposite way to opaque bodies. Glass and mica can be rendered athermanous and silent by making the carbon deposit sufficiently thick. Zinc, copper, and ebonite can produce sonorous effects by a proper disposition of carbon. The effect in these latter cases may be due either to molecular pressure, in fact to a radiometer effect, though very feeble in intensity; or it may be the result of conduction through the mass of the diaphragm, that is, radiant heat is reduced to thermometric heat by absorption by the carbon deposit on the *outside* of the disk; and this heat is transmitted through the disk and radiated to the absorbent gases in the interior.

Several experiments were made which fully establish the inference that the effect is one of conduction, and that the blackened surface of an opaque body like zinc acts as though the source of heat were transferred to the outside surface of the disk.

Tubes of various sizes and dimensions were now tried to confirm Messrs. Bell and Tainter's observations on tubes. They invariably gave out satisfactory sounds when the intermittent rays were directed into the interior of the tubes, which were always considerably intensified by blackening their interiors and closing the open end with a glass plate.

It was shown that there is a time element, and that the loudness of the note emitted depends upon the rapidity with which the contained air not only absorbs the degraded energy, but upon the rapidity with which it gives up its heat to the sides of the case and the exits open to it. Though the pitch of the maximum note varied with the cavity and the amount of radiant heat transmitted, its quality never varied, notwithstanding the great diversity of materials used as diaphragms.

Since these sonorous effects are due to the expansions of absorbent gases under the influence of heat, and since wires are heated by the transference of electric currents through them, it seemed possible that if we inclosed a spiral of fine platinum wire in a dark cavity, well blacked on the inside, and sent through it by means of the wheel-break, rapid intermittent currents of electricity from a battery, heat would be radiated, the air would expand, and sounds would result. This was done, and the sounds produced were excellent. In fact, with four bichromate cells sounds more intense than any previously observed were obtained.

Furthermore it was evident that if the wheel-break were replaced by a good microphone transmitter, articulate speech should be heard. This was done, and an excellent telephone receiver was the consequence, by means of which speech was perfectly reproduced.

The explanation of these remarkable phenomena is now abundantly clear.

It is purely an effect of radiant heat, and it is essentially one due to the changes of volume in vapours and gases produced by the degradation and absorption of this heat in a confined space. The disks in Bell and Tainter's experiments must be diathermanous, and the better their character in this respect the greater the effect; remove them, and the effect is greater still. Messrs. Bell and Tainter (*Journal* of Society of Telegraph Engineers, December 8, 1880) showed that the sounds maintained their *timbre* and pitch notwithstanding variation in the substance of the disk, and M. Mercadier found that a split or cracked plate acted as well as when it was whole. These facts are consistent with the expansion of the contained air, but not with any mechanical disturbance of the disks. Moreover M. Mercadier showed that the effect was improved by lampblack, but he applied it in the wrong place.

The disks may, and perhaps do, under certain conditions, vibrate, but this vibration is feeble and quite a secondary action. The sides of the containing vessel must possess the power to reduce the incident rays to thermometric heat, and impart it to the vapour they confine, and the more their power in this respect, as when blackened by carbon, the greater the effect. The back of the disk may alone act in this respect. Cigars, chips of wood, smoke, or any absorbent surfaces placed inside a closed transparent vessel will, by first absorbing and then radiating heat rays to the confined gas, produce sonorous vibrations.

The heat is dissipated in the energy of sonorous vibrations. In all cases, time enters as an element, and the maximum effect depends on the diathermancy of the exposed side of the cavity, on its dimensions and surfaces, and on the absorbent character of the contained gas.

THE EARTHQUAKE IN ISCHIA

THE Island of Ischia, the Pithecusa of the ancients, is some twenty miles in circumference, and appears to be the continuation of the north-western boundary of the Gulf of Naples It consists of an old volcanic mountain sloping down on all side to the sea. The southern rim of the old crater has been remove by denudation, leaving the northern as a curved serrated ridge, forming the peak of Monte Epomeo.

Situated on the southern slopes of the island are only a few and unimportant villages.

Going from east to west along the northern slope we have first the capital Ischia, then we encounter the great trachytic lava stream which issues laterally from the slope of Epomeo, and after a course of two miles entered the sea, forming a promontory. This is the so-called lava Del' Arso, of A.D. 1302. Next are encountered two very fresh-looking craters, from which lava streams have flowed. Then we come to Casamicciola, a small town of about 4000 inhabitants, to the north-west of which is the village of Lacco Ameno. At the eastern end of the island is the town of Forio.

The district in which are situated Casamicciola and Lacco is thus bounded on the north by the sea, on the south by the ridge of Monte Epomeo, on the west by a spur stretching from the latter into the sea, forming the Punta Cornacchia, and on the east are the two hills called Monte Rotaro and Montagnone, the new-looking craters already spoken of.

It is worth observing that from this side of the island the four or five historic eruptions have occurred, and all the principal thermo-mineral springs are confined mostly to this district.

It is at this very spot that the late earthquake has taken place, resulting in the total destruction of Casamicciola, with the exception of the hotels, baths, and a few well-constructed private houses. A hundred and twenty bodies have been excavated, and they are not all, besides 160 seriously wounded. At the village of Lacco thirteen houses have fallen, and five deaths are reported.

On March 4, at five and a half minutes past one p.m., a terrific shock shook the whole island, but its maximum intensity was at this point leaving Ischia and Forio almost uninjured, together with the villages on the opposite side of the mountain.

There was but a moment of premonitory trembling, when the terrific blow shook the houses about the ears of their inhabitants. The corpse of the shoemaker was found in his usual position, with the last between his knees, and we saw the corpse of a woman with the half-finished stocking in her hand and the needle in its sheath. The two cases show the suddenness of the catastrophe.

The first shock was described as a sudden blow beneath the feet, followed by a series of undulations, which appear from accounts to have radiated from a point which I shall immediately describe. This was followed shortly by faint vibrations, accompanied by loud subterranean thunder, such as was heard in the slight earthquake of last July.

On visiting the island a few hours after we were struck by the severity of the shock and by its extremely limited area. Following the methods adopted by our eminent countryman Mr. Mallet, F.R.S., in his investigations of the great Neapolitan earthquake of 1857, we have come to the conclusion that the undulations occurred in a series of closed curves radiating from a point which must have been situated about a quarter of a kilometre to the south-west of the upper town, that is in the direction of Lacco.

It is interesting to note that the seismographs at Naples and Vesuvius were not at all affected by the earthquake. This led Prof. Palmieri to conclude from the extremely local effects produced that the phenomenon was due to the excavation and removal of matter by the mineral springs and the collapse and falling in of the superincumbent ground. It seems difficult to satisfy oneself with the theory of my respected teacher and friend Prof. Palmieri for the following reasons :—

1. The collapse of earth in Cheshire in no way produces effects at all similar or equivalent to those under consideration, and yet the amount of salt in solution removed is equal to much more solid matter than is removed by the dilute mineral waters of Ischia which are also small in quantity. Landslips like that of Lyme Regis are quite incomparable in effects to the present case.

2. The waters that issued immediately after the disaster were as usual clear, and flowed at the same rate. If this explanation was tenable, then the collapse of the earth should have forced out a large body of water and vapour and have rendered the former turbid and muddy. Such however was not the case.

3. The disturbance in Ischia was coincident with the seismic movements that were felt in various parts of Europe from the 2nd to the 5th of March, and which was severe throughout Northern Italy.

We know from the following facts that Ischia cannot be reckoned amongst extinct volcanoes. The great number of fumaroles and thermo-springs that exist on its surface ; the sand on the sea-shore in some parts is so hot a few inches from the surface that the hand cannot be borne in it ; the continual seismic disturbances to which it was and is subject—all point to the conclusion that there still exists igneous matter not far from the surface.

The seismic waves of the beginning of March causing increased tension in the igneous matter through which they travelled would tend to rupture the superficial crust at its weakest point ; the Island of Ischia presents to us such suitable conditions, and the volcanic matter, vapour, or lava may by those means have endeavoured to force its way towards the surface.

The formation of a fissure, together with the blow that would be produced by the immediate falling of such, would explain the phenomena. Much the same results occur from the formation of a dyke in an active volcanic mountain ; in fact the conditions may be looked upon as analogous.

Although lava has failed to reach the surface on the present occasion, a repetition may be sufficient to produce an eruption such as has often occurred at this spot. We may look for the homologues of the present earthquake in that of A.D. 63, preceding the outburst of Vesuvius in 79, or those that disturbed Pozzuoli and its neighbourhood immediately before the formation of Monte Nuovo, but which were not felt at Naples.

The fact that the undulations produced little effect on the southern side of the island shows the extreme thinness of the earth-crust at this spot ; the weight and bulk of the superficial configuration acting as deterrent agents to the propagation of the seismic undulations to any great distance. The earthquakes in Ischia have at times been very disastrous, compelling various Greek colonies to forsake the island. There is generally a slight shock about once a year, nearly always accompanied by subterranean thunder. These have sometimes caused injuries, as on February 2, 1828, when three or four houses fell and some thirty people were killed. The details of the observations being made will be published as soon as they can be formulated.

It is an interesting fact that since writing the above, on comparing notes with Signor P. Franco, my colleague, although our observations were quite independent and unknown to each other, yet we have arrived at exactly the same conclusion in almost every detail.

H. J. JOHNSTON-LAVIS

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following notice respecting scholarships in Natural Science has been published by Merton College :—

There will be an election in June next to one (or two) Physical Science Postmasterships.

The examination will begin on Tuesday, June 28 ; it will be held in common with Magdalen College, and at the same time and place. Candidates may give in their names at either College, but all will be regarded as standing at both, unless special notice is given to the contrary. In the event of election a candidate will be requested to state which College he would prefer. The Postmasterships are of the annual value of 80*l.*, and are tenable for five years from election, provided that the holder does not accept or retain any appointment incompatible with the pursuance of the full course of University studies. After two years' residence the College may raise, by a sum not exceeding 20*l.* per annum, the Postmastership of such Postmasters as shall be recommended by the Tutors for their character, industry, and ability. Candidates for the Postmasterships, if members of the University, must not have exceeded six terms of University standing, but there is no limit of age. The subjects of examination will be Chemistry and Physics. There will be a practical examination in Chemistry. Candidates will have an opportunity of giving evidence of a knowledge of Biology ; but it must be borne in mind that in such cases the examiners will look for evidence of an acquaintance with the principles of Chemistry and Physics at least equal in extent to that which is required in the Preliminary Honour Examination in the Physical Science School. A paper will be set in Algebra and Elementary Geometry (Books I.-VI.), and a Classical paper of the standard required by the University for Responsions.

Magdalen College has published the following notice respecting Natural Science Scholarships (Demyships) :—There will be an election at this College in June next to not less than seven Demyships, of which one at least will be Mathematical, one at least in Natural Science, and the rest Classical. No person will be eligible for the Demyships who will have attained the age of twenty years on October 10 next. The stipend of the Demyships is 95*l.* per annum, inclusive of all allowances : and they are tenable for five years, provided that the holder does not accept or retain any appointment which in the judgment of the electors will interfere with the completion of his University studies.

THE Oldham Lyceum and Science and Art Schools, opened by Lord Derby last Thursday, seems to be a handsome and useful building, and under Mr. Phythian's superintendence we have no doubt much good work will be done in the future as in the past. Chemical and physical laboratories and other arrangements of scientific work have been provided for.